

TAB I

TAB I

PART 1

08/19/97 235 488 Class Subclass ISSUE CLASSIFICATION SCANNED B		6036099 6036099	
UTILITY SERIAL NUMBER 08/918,582		PATENT DATE MAR 14 2000	
PATENT NUMBER 6036099		EXAMINER SHERR	
SERIAL NUMBER 08/918,582		FILING DATE 08/19/97	
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GROUP ART UNIT 2876		EXAMINER SHERR	
APPLICANTS KEITH LEIGHTON, LORAIN, OH.			
CONTINUING DATA VERIFIED CIP of 08/927,789 10/1/96 now Patent 5,817,207 DHS			
FOREIGN APPLICATIONS VERIFIED DHS			
FOREIGN FILING LICENSE GRANTED 01/26/98 ***** SMALL ENTITY *****			
Foreign priority claimed 35 USC 119 conditions met Verified and Acknowledged Examiner's Initials DHS		AS FILED STATE OR COUNTRY OH	
SHEETS DRWGS. 6		TOTAL CLAIMS 24	
INDEP. CLAIMS 3		FILING FEE RECEIVED \$429.00	
ATTORNEY'S DOCKET NO. 60142		ADDRESS MARK A. WATKINS OLDHAM & OLDHAM CO 1225 WEST MARKET STREET AKRON OH 44313-7188	
TITLE HOT LAMINATION PROCESS FOR THE MANUFACTURE COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM			
U.S. DEPT. OF COMM./PAT. & TM—PTO-436L (Rev.12-94)			
PARTS OF APPLICATION FILED SEPARATELY		4/13/99 Application Examiner	
NOTICE OF ALLOWANCE MAILED 4/12/99		CLAIMS ALLOWED Total Claims 18	
ISSUE FEE Amount Due \$60.00		Date Paid 7-13-99	
Label Area		DRAWING Sheets Drwg. 48	
Figs. Drwg. 11		Print Fig. 3AB	
ISSUE BATCH NUMBER R55		PREPARED FOR ISSUE	
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Form PTO-436A (Rev. 8-92)

SCAN 8 Formal Drawings (4 sheets) set 1

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Formal Drawings / sheet set

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89350 U.S. PTO

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PATENT APPLICATION



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	1. Application <u>10</u> papers.	
	2. <u>I.D.S.</u>	
<u>11/9/98</u>	3. <u>Rej (3 months)</u>	<u>10-17-97</u>
<u>4-2-99</u>	4. <u>Ext of Time (1)</u>	<u>11/15/97</u>
<u>4-2-99</u>	5. <u>Amtd A</u>	<u>3-19-99</u>
<u>11/12/99</u>	6. <u>Allowance</u>	<u>3-19-99</u>
<u>6/8/99</u>	7. <u>Amtd B (312)</u>	<u>4/12/99</u>
<u>7/14/99</u>	8. <u>PTO-271</u>	<u>5-27-99</u>
<u>11-4-99</u>	9. <u>Suppl. Decl.</u>	<u>7-14-99</u>
<u>11-4-99</u>	10. <u>Amtd C</u>	<u>7-12-99</u>
<u>11-4-99</u>	11. <u>Amtd D</u>	<u>8-9-99</u>
	12. <u>PTOL 271</u>	<u>11-4-99</u>
<u>02-17-99</u>	13. <u>Formal Draw (4 sheets) set 1</u>	<u>6-22-99</u>
	14. <u>Letter: re CPA</u>	<u>8/19/99</u>
	15. <u>Ref Cp Rule 32B</u>	<u>3/22/02</u>
	16. <u>Director</u>	<u>8/29/02</u>
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SEARCHED			
Class	Sub.	Date	Exmr.
235	488 492 486 375/E		
360	2	11/3/98	DHS
235	488 492 486 375		
360	2		
156	182 154 267 311 312	4/7/99	DHS

INTERFERENCE SEARCHED			
Class	Sub.	Date	Exmr.
235	488 492 486 375	4/7/99	DHS

SEARCH NOTES		
	Date	Exmr.
Talked to Tien Le	11/3/98	DHS
APS	11/3/98	DHS
Adrienne Johnson class 156	4/7/99	DHS
Richard Crispino class 156	4/7/99	DHS

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POSITION	ID NO.	DATE
CLASSIFIER		10/20/97
EXAMINER	70998	1-20-98
TYPIST		
VERIFIER		
CORPS CORR.		
SPEC. HAND		
FILE MAINT.		
DRAFTING		

INDEX OF CLAIMS

Claim	Date
1	11/4/97
2	11/4/97
3	11/4/97
4	11/4/97
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6	11/4/97
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SYMBOLS

✓ Rejected
 = Allowed
 - (Through numeral) Cancelled
 + Restricted
 N Non-elected
 I Interference
 A Appeal
 O Objected



US006036099A

United States Patent**Leighton****[11] Patent Number: 6,036,099****[45] Date of Patent: Mar. 14, 2000**

[54] **HOT LAMINATION PROCESS FOR THE MANUFACTURE OF A COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM**

[76] Inventor: **Keith Leighton**, 2817 Fulmer Rd., Lorain, Ohio 44053

[21] Appl. No.: **08/918,582**

[22] Filed: **Aug. 19, 1997**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/727,789, Oct. 7, 1996.

[51] Int. Cl.⁷ **G06K 19/02; G06K 19/06; B32B 31/00; C09S 5/02**

[52] U.S. Cl. **235/488; 235/492; 156/182; 156/154; 156/267; 156/311; 156/312**

[58] Field of Search **235/488, 492, 235/486, 375; 360/2; 156/182, 154, 267, 311, 312**

[56] References Cited**U.S. PATENT DOCUMENTS**

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Primary Examiner—Donald Hajec

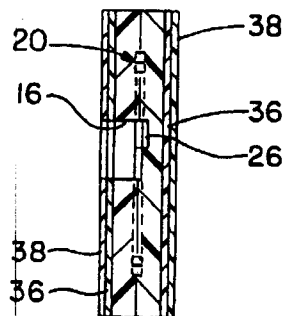
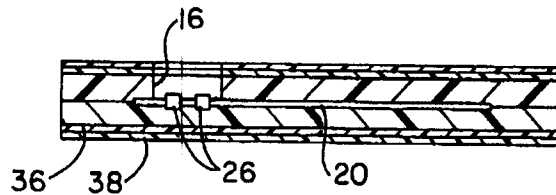
Assistant Examiner—Daniel Sherr

Attorney, Agent, or Firm—Oldham & Oldham Co., L.P.A.

[57] ABSTRACT

A plastic smart card, such as a card having a radio frequency identification (RFID) proximity function, including at least one electronic element embedded therein and a physical contact card function and the hot lamination process for the manufacture of this dual function smart card and other plastic cards including a micro-chip embedded therein. The process results in a card having a preferred overall thickness in the range of 0.028 inches to 0.032 inches with a surface suitable for receiving dye sublimation printing—the variation in card thickness across the surface should not exceed 0.0005 inches. A card manufactured in accordance with the present invention also complies with all industry standards and specifications. Also, the hot lamination process of the present invention results in an aesthetically pleasing card. The invention also relates to a plastic card formed in accordance with the hot lamination process of the present invention.

18 Claims, 4 Drawing Sheets



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FIG. - 1

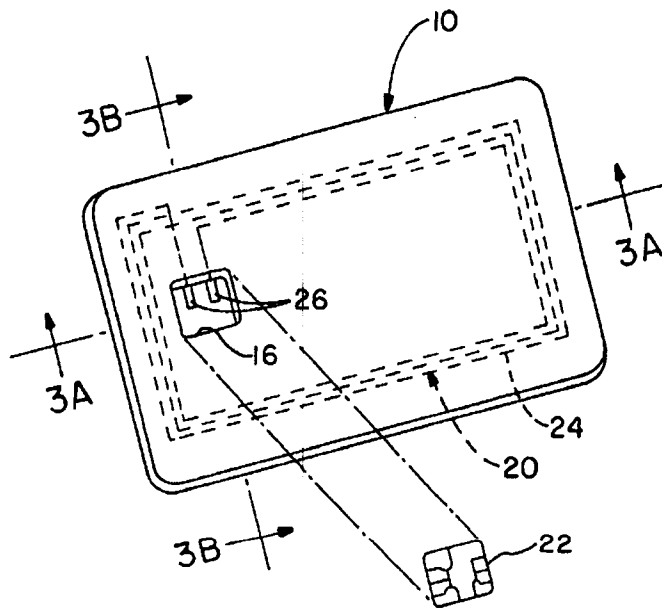
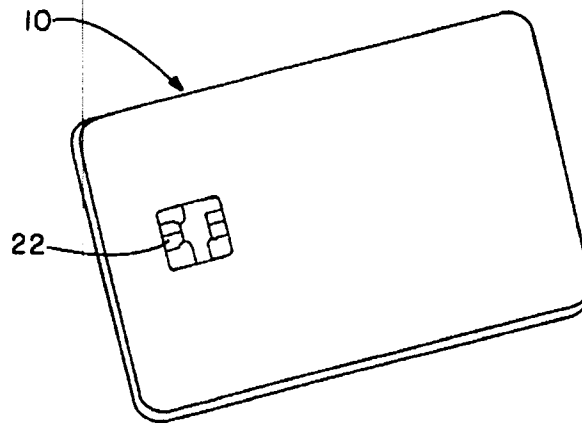


FIG. - 2

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FIG. - 2A

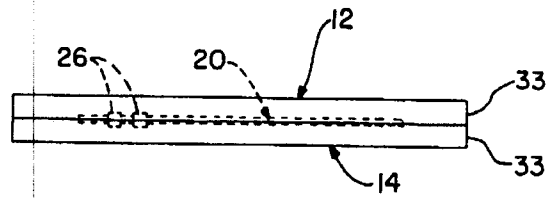


FIG. - 3A

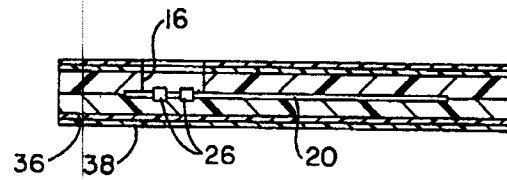


FIG. - 3B

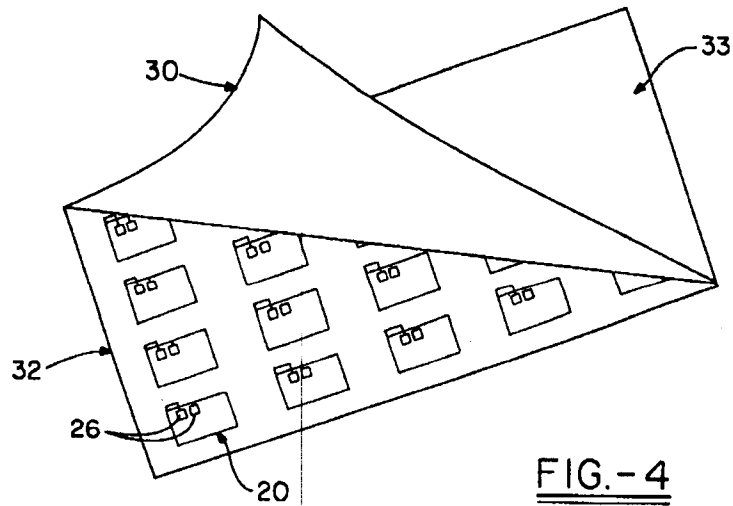
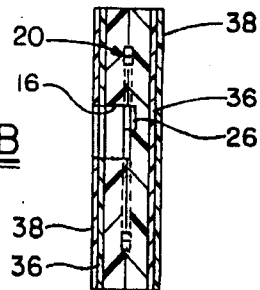


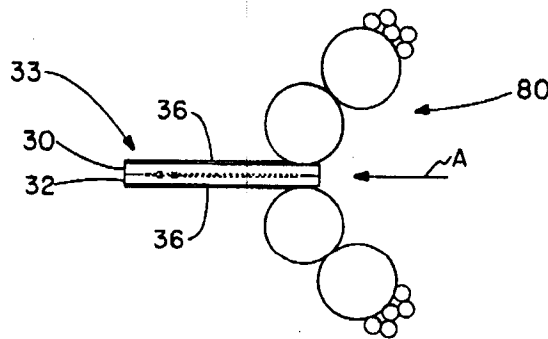
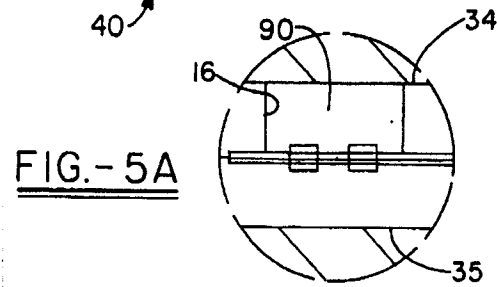
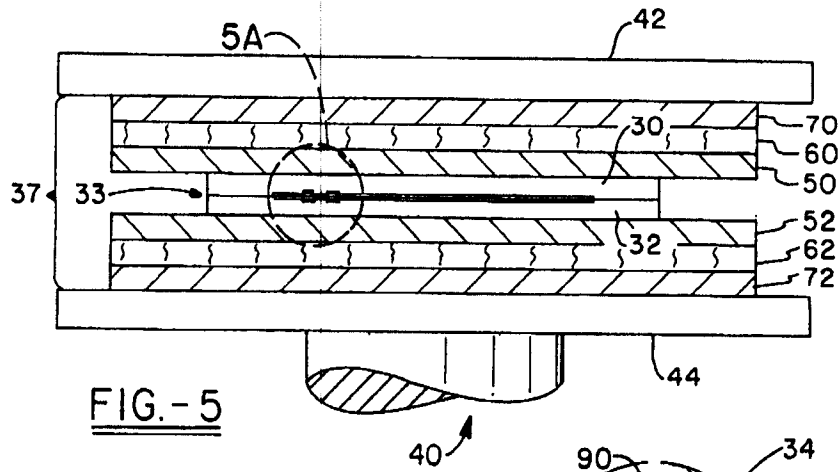
FIG. - 4

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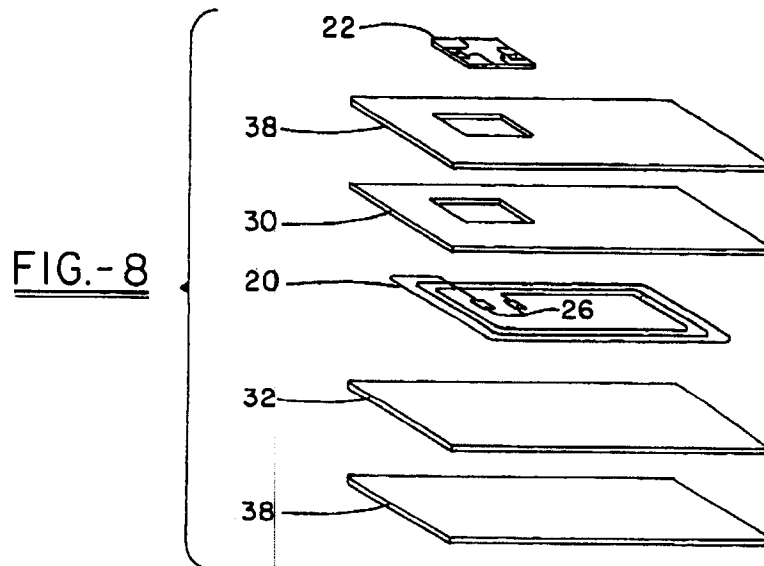
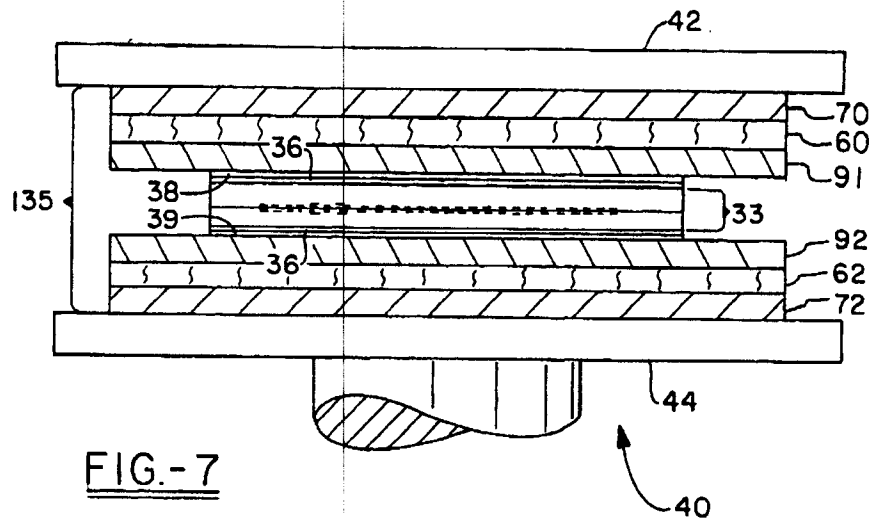


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HOT LAMINATION PROCESS FOR THE MANUFACTURE OF A COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM

This application is a continuation-in-part of copending application Ser. No. 08/727,789 filed Oct. 7, 1996.

FIELD OF THE INVENTION

The present invention relates generally to plastic cards and the manufacture thereof by a hot lamination process, and more particularly to smart cards and the manufacture of these such that they conform to industry size and performance standards and conventions and that have a superior outer surface as compared to known smart cards such that the card may receive dye sublimation printing or the like. Even more specifically, the preferred embodiments of the present invention relate to dual function cards containing imbedded electronic elements as well as an exposed electronic contact surface.

BACKGROUND OF THE INVENTION

As the use of plastic cards for credit cards, automated teller machine (ATM) cards, identification cards, and like continues to become more widespread, the problems associated with the use of such cards correspondingly increase. Credit card fraud and identification card fraud are becoming larger problems everyday, and this fraud has introduced uncertainties into our systems of commerce and our security systems. Using easily available technology, criminals are able to manufacture credit/debit cards, ATM cards, identification cards, and the like having another's account code, identification code, or other personal information embedded in the magnetic stripe thereof. Thus, for example, criminals may steal hundreds or thousands of legitimate credit card account numbers and manufacture many additional cards bearing the stolen information. These fraudulent cards are then usable by the criminals to purchase goods and to receive cash with the legitimate card holder and the card issuer left holding the bill.

Likewise, so called debit cards are becoming increasingly popular. These cards have stored thereon a certain amount of value for which the card owner has previously paid. For example, a subway rider may purchase a card good for X fares, with one fare being deducted from the card each time the owner rides the subway. Criminals have also been able to manipulate the data stored on these cards to defraud the merchants and others.

The ease in which criminals have been able to manufacture and/or manipulate known cards results from the existence of the easily altered magnetic stripe storage medium used by known cards. These magnetic stripes are easily programmed and reprogrammed using commonly available technology. Thus, there has been found a need in the plastic card industry to provide a more secure plastic card that is very difficult or impossible to fraudulently manipulate.

The likely successor to magnetic stripe cards is known as a memory or smart card. A smart card can generally be described as a card having an integrated circuit with memory that is capable of making decisions. The category of smart cards can be further divided into subcategories based on the type of memory or type of communication with an associated card reader. Types of smart cards include contact cards (cards requiring physical touch between the terminal reader and the surface of the card) and contactless cards (cards which interact with the terminal reader using a electromag-

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netic coupling). Contactless cards may also be referred to as "proximity" cards. This technology may serve as a substitute for or be provided as an addition to the magnetic stripe on a card.

One specific type of smart card is a dual function contact/contactless microprocessor chip plastic card commonly referred to in the industry as a dual function card. This card utilizes a single microprocessor to control both physical contact and proximity features of the card.

While these smart cards have been found to have infinitely more capability than magnetic stripe cards as well as being more successful in preventing or limiting fraud, they are more difficult and expensive to manufacture relative to ordinary magnetic stripe cards. One of the biggest obstacles to the wide spread manufacture and use of smart cards has been the inability of card manufacturers to manufacture a smart card that meets all industry standards and specifications, such as those set by the International Standards Organization (ISO), that are sufficiently aesthetically pleasing (wherein the embedded electronics are hidden from view), and that have a sufficiently regular or flat surface such that one or both surfaces of the card may be printed on using the very popular and widespread dye sublimation technology.

Limitations to known plastic cards with embedded computer chips and electronics are that they a) are too thick to work in connection with existing card reading machinery (ATM machines, telephones, b) have a surface that is too irregular to properly and consistently receive dye sublimation printing, c) utilize manufacturing processes making the cards cost prohibitive. Moreover, prior attempts to manufacture a sufficiently thin plastic card including a computer chip embedded therein have resulted in a card with inferior aesthetic qualities such as the ability to see the embedded computer chip through the plastic.

Furthermore, due to the presence of both internal and surface electronics within the card, the manufacture of a dual function card presents its own unique set of obstacles and problems, different from the manufacture of cards with fully embedded electronics.

SUMMARY OF THE INVENTION

The present invention is therefore directed to a hot lamination method for the manufacture of a plastic card having at least one electronic element embedded therein as well as at least one electronic element with an exposed contact surface and to such plastic cards. The card has an overall thickness in the range of 0.028 inches to 0.032 inches and comprises a plastic core having at least one electronic element embedded therein with at least one of the upper and lower surfaces of the core comprising a coating printed or otherwise applied thereon. A portion of the card's outer surface exposes a contact surface electronic element operatively connected to the card's internal electronics. An overlaminated film is preferably provided over the coated surface of the core and the resulting card has a variation in thickness across the surfaces thereof of no greater than approximately 0.0005 inches.

The hot lamination method of the present invention comprises the steps of providing upper (first) and lower (second) plastic core sheets, positioning at least one electronic element between the first and second core sheets to thus form a core, and placing the core in a laminator and closing the laminator with minimal or no laminator ram pressure applied to the core. A heat cycle is applied to the core sheets in the laminator to cause complete or partial flow

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of the plastic sheets. The laminator ram pressure is then increased in combination with the heat. A cooling cycle is then applied to the core in the laminator, preferably with an associated increase in ram pressure, and the core is removed from the laminator.

In the preferred embodiment, the laminated core next undergoes a controlled depth milling operation to expose one or more contact pads which comprise part of the internal, embedded electronic element.

In alternative embodiments, one of the plastic sheets contained a pre-formed window which is positioned over the contact pads, prior to lamination. A spacer, integral to the corresponding platen or separate therefrom, is utilized to prevent or limit the flow of plastic into the window region so as not to coat the contact pads with plastic during the card manufacturing process.

At least one surface of the core is then printed on using a printing press or similar printing apparatus, a sheet of overlamine film is placed on at least one side of the core, and the core is once again placed in a laminator. A heat cycle is applied to the core with its overlamine film, and a cooling cycle is thereafter applied, resulting in a sheet of plastic card stock from which one or more cards may be cut.

Contact surface elements are installed into the window region of a plastic card and in operable contact with contact pads.

The invention is also directed to a card manufactured in accordance with the above process which results in a plastic card having a thickness in the range of approximately 0.028 inches to 0.032 inches with a surface smoothness of at least approximately 0.0005 inches as is required by International Standards Organization (ISO) and American National Standards Institute (ANSI) standards.

The present invention provides numerous advantages over known plastic cards and known plastic card manufacturing processes, and includes the formation of a plastic card with electronic elements such as a computer chip embedded therein with a pleasing aesthetic appearance, having a sufficiently smooth and regular surface such that the card may receive dye sublimation printing, and possessing sufficient durability and characteristics to comply with all industry specifications and standards.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a plastic card in accordance with the present invention;

FIG. 2 is a perspective view of the card shown in FIG. 1, illustrating the embedded and exposed electronics incorporated into the card;

FIG. 2A is a side elevational view of the card core illustrating various electronic elements that may be embedded in a card in accordance with the present invention;

FIG. 3A is a cross sectional view of the card illustrated in FIG. 2, taken through section line 3A—3A.

FIG. 3B is a cross sectional view of the card illustrated in FIG. 2, taken through section line 3B—3B.

FIG. 4 is a perspective view of a plurality of electronic elements positioned on a sheet of plastic core stock and covered by a second sheet of plastic core stock.

FIG. 5 is a schematic cross sectional view illustrating a book comprising the core, containing electronics, as positioned in a laminator;

FIG. 5A is an enlarged cross-sectional view of the portion encircled in FIG. 5 for an alternative embodiment, utilizing a spacer, for producing a card according to the present invention;

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FIG. 6 schematically illustrates the process of printing on the core;

FIG. 7 is a schematic cross sectional view illustrating the core with overlamine film, as placed in a laminator;

FIG. 8 is an exploded view of a plastic card produced by the process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a plastic card including at least one electronic element embedded therein. The present invention also relates to a hot lamination process for the manufacture of plastic cards, and more particularly to a hot lamination process for the manufacturer of plastic cards that include an electronic element, such as a computer chip or other electronic element embedded therein. The electronic element may perform a wide variety of functions and take a wide variety of forms. Such cards, without regard to the particular electronic element embedded therein, will hereinafter be referred to as smart cards. The present invention also relates to a card formed in accordance with the invention.

In its preferred embodiment and as illustrated in FIGS. 1 and 2, the present invention relates to the manufacture of a dual function card, a particular type of smart card which utilizes a dual function contact/contactless microprocessor chip, as described previously herein. However, it will be appreciated by those skilled in the art, that the method of hot lamination described herein could easily be applied to other identity card or smart card applications.

Referring now to FIGS. 1, 2, and 2A there can be seen a plastic card 10 manufactured in accordance with the present invention and including an electronic element, generally 20, embedded therein. Card 10 includes an upper surface 12 and a lower surface 14. Electronic element 20 may take a wide variety of forms (microprocessor chip, circuit board, transponder, etc.) and perform a wide variety of functions. As shown in FIGS. 2, 2A, and 3A, electronic element 20 may comprise a read/write micro-chip 22 including a wire antenna 24 connected thereto, any other suitable electronic element. These electronic elements 20, 22 and 24 and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements embedded therein such that the cards 10 are of a superior quality, meet all ISO and other industry specifications and standards, and are sufficiently smooth and otherwise is capable of receiving dye sublimation printing. Electronic elements such as these described are available from manufacturers such as Motorola and Philips Electronics.

Upper surface 12 contains a window or cavity 16 formed therein and intended to expose one or more contact pads 26 operatively connected to antenna 24. Upon formation of card 10 in accordance with the preferred embodiment, a microprocessor chip 22 is inserted into window 16 and in electrical connection with contact pads 26. This microprocessor chip may function as a "proximity" or radio frequency identification (RFID) card in conjunction with antenna 24 when electromagnetically used with a compatible terminal reader. Microprocessor chip 22 is also capable of function as a contact card, requiring physical contact between a compatible terminal reader and the surface of chip 22. It should be appreciated that the contact function of the card may be accomplished by any contact sensor whether integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

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Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of the microprocessor chip 22 surface as well as to the surface of plastic portion of card 10. It is to be appreciated that cards having a thickness greater than 0.032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in FIG. 4, one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20, including contact points 26, between first and second sheets of card stock 30, 32 to form a core 33. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32. When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32, electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in FIG. 5, laminator 40 includes upper and lower platens 42, 44 for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42, 44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads 60, 62 and the entire assembly forms a book 35 for being positioned in laminator 40 between platens 42, 44.

Once book 35 is positioned in laminator 40 as shown in FIG. 5, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book 35. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens 42, 44 up to a range of 275° F. to 400° F., and most preferably up to a range of 300° F. to 370° F. for a period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that

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the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

Once the heat cycle has been applied to book 35 as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 become encapsulated thereby, and so that sheets 30, 32 form a uniform core 33 with upper and lower surfaces 34, 35. The ram pressure translates into an effective pressure on core 33 in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core 33, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates 50, 52 provides surfaces 34, 35 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10-15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core 33 surface, was applied for 10-15 minutes to form a uniform core 33, using sheets 30, 32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 35 during which time the ram pressure of the laminator 40 is increased, preferably by approximately 10-40% and most preferably about 25% until the platens 42, 44 have cooled so as to return the core material to a solid state. In the preferred method the platens 42, 44 are cooled to approximately 40° F. to 65° F. for approximately 10-15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in FIG. 6, core 33 is coated on at least one of its upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in FIG. 6, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 can also serve to cosmetically hide the one or more electronic elements 20 that are embedded within core 33, and prevent these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to FIG. 7, the final preferred, but optional processing of core 33, which now comprises a layer of ink 36 or the like on at least one surface 34, 35 thereof, is

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schematically illustrated. An overlamine layer such as clear overlamine film 38 is positioned on at least one ink coated surface 34,35 of core 33, and preferably core 33 is positioned between two similar sheets of overlamine film 38,39 as shown. Overlamine film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is schematically illustrated in FIG. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlamine film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 91, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to FIG. 7.

When book 135 is positioned between upper and lower platens 42,44 of laminator 40 as shown in FIG. 7, the laminator is closed and a heat cycle in the range of 175° F. to 300° F., and most preferably in the range of 180° F. to 275° F., is applied to book 135 for a period of 10 to 25 minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250-350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlamine layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40° F. to 65° F. and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlamine layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlamine layer 38 and should not cause softening or re-flow of plastic core 33. In lieu of this preferred overlamination process, it is to be understood that colorfast inks may not require an overlamine layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34,35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlamine film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34,35 with a layer of ink 36 which is positioned between layers of overlamine film 38,39, all of which has been laminated together as described and as shown in FIG. 8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12,14 at preferably both surfaces 12,14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

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In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy) or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26 and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in FIG. 5a, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon™. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims.

What is claimed is:

1. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:

- (a) providing first and second plastic core sheets;
- (b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;
- (c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle; said heat and pressure cycle comprising the steps of:
 - (i) heating said core for a first period of time;
 - (ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;
 - (iii) cooling said core while applying a second pressure to said core;

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- (d) coating at least one of said outer surfaces of said core with a layer of ink;
- (e) milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said electronic element.
2. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said laminator apparatus has first and second laminating plates, at least one of said first and second laminating plates having a matte finish for creating a textured surface on at least one of said outer surfaces of said core.
3. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 2, wherein each of said first and second laminating plates has a matte finish for creating said textured surface on both of said outer surfaces of said core.
4. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, each of said sheets having a thickness in the range of 0.007 to 0.024 inch.
5. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 5, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inch.
6. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said second pressure is greater than said first pressure.
7. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 6, wherein said second pressure ranges from about 10% to about 40% greater than said first pressure.
8. A hot lamination process as recited in claim 1 having a further step following step (d), said step comprising: positioning said core in a laminator apparatus with a layer of overlamine film on at least one of said upper and lower surfaces of said core and laminating said layer of overlamine film to said core in said laminator to thereby form a sheet of plastic card stock.
9. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said core is heated in step (c)(i) to a temperature in the range of 275° F. to 400° F. and said first period of time is at least five (5) minutes.
10. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first pressure is approximately 450 p.s.i. and said second period of time is at least 10 minutes.
11. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said step (d) is carried out utilizing a printing press.
12. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said step (d) is carried out utilizing a coating technique selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing and litho-printing.

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13. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said step (e) of applying a layer of overlamine film comprises the further steps of:
- (a) positioning an overlamine film on at least one ink coated surface of said core;
 - (b) subjecting said core to a second heat and pressure cycle comprising the steps of:
 - (i) heating said core to a temperature between approximately 175° F. to 300° F. for approximately 10 to 25 minutes;
 - (ii) applying approximately 1000 p.s.i. pressure to said core; and
 - (iii) cooling said core to a temperature in the range of approximately 40° F. to 65° F. for approximately 10 to 25 minutes.
14. A hot lamination process is recited in claim 1 comprising the further step of inserting an electronic contact element into said cavity.
15. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board antenna or an associated wire antenna.
16. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.
17. A process for incorporating at least one electronic element having at least one electronic subcomponent in the manufacture of a plastic card, comprising the steps of:
- (a) providing first and second plastic core sheets, at least one core sheet having a cavity formed therein;
 - (b) positioning said at least one electronic element in the absence of a non-electronic carrier between said first and second plastic core sheets to form a layered core, said plastic core sheets defining a pair of inner and outer surface of said core, and said cavity positioned so as to expose said at least one electronic subcomponent therein;
 - (c) inserting a spacer into said cavity, said spacer substantially filling said cavity and covering said at least one electronic subcomponent;
 - (d) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:
 - (i) heating said core for a first period of time;
 - (ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;
 - (iii) cooling said core while applying a second pressure to said core;
 - (e) coating at least one of said outer surfaces of said core with a layer of ink;
 - (f) removing said spacer from the cavity of said core.
18. A hot lamination process as recited in claim 17, wherein said electronic sub-component comprises one or more elements from the group consisting of a microprocessor chip, a contact pad, a transponder and a contact sensor.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,036,099
DATED : March 14, 2000
INVENTOR(S) : Keith R. Leighton

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1.

Line 7, replace "Oct. 7, 1996" with --Oct. 7, 1996, which claimed the benefit of provisional application serial no 60/005,685, filed on October 17, 1995, filed on October 17, 1995. This application claims the benefit of provisional application serial no. 60/024,255, filed August 21, 1996 --.

Signed and Sealed this

Twenty-fourth Day of September, 2002

Attest:



Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

69350 U.S. PTO
08/918582
08/19/97

PATENT APPLICATION SERIAL NO. _____

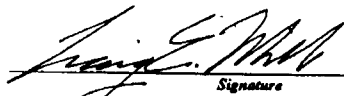
U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

10/27/1997 SCHAPMAN 00000032 08918582
01 FC:201 385.00 DP
02 FC:203 44.00 DP

Jc512 U.S. PTO

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A #

PATENT APPLICATION TRANSMITTAL LETTER (Small Entity)		Docket No. 6014-2
TO THE ASSISTANT COMMISSIONER FOR PATENTS		
Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:		
Keith R. Leighton		
For: HOT LAMINATION PROCESS FOR THE MANUFACTURE COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM		
Enclosed are:		
<input checked="" type="checkbox"/> Certificate of Mailing with Express Mail Mailing Label No. EM170479073US <input checked="" type="checkbox"/> Six (6) informal sheets of drawings. <input type="checkbox"/> A certified copy of a _____ application. <input checked="" type="checkbox"/> Declaration <input checked="" type="checkbox"/> Signed. <input type="checkbox"/> Unsigned. <input checked="" type="checkbox"/> Power of Attorney <input type="checkbox"/> Information Disclosure Statement <input type="checkbox"/> Preliminary Amendment <input checked="" type="checkbox"/> 2 sheets Verified Statement(s) to Establish Small Entity Status Under 37 C.F.R. 1.9 and 1.27. <input type="checkbox"/> Other:		
CLAIMS AS FILED		
For	#Filed	#Allowed
Total Claims	24	- 20 =
Indep. Claims	3	- 3 =
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>		\$0.00
BASIC FEE		\$385.00
TOTAL FILING FEE		\$429.00
<input checked="" type="checkbox"/> A check in the amount of \$429.00 to cover the filing fee is enclosed. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge and credit Deposit Account No. 15-0450 as described below. A duplicate copy of this sheet is enclosed. <input type="checkbox"/> Charge the amount of _____ as filing fee. <input checked="" type="checkbox"/> Credit any overpayment. <input checked="" type="checkbox"/> Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17. <input type="checkbox"/> Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).		
Dated: 8-17-97		
 Signature Craig E. Miller, Reg. No. 33,427 Oldham & Oldham Co., LPA 1225 West Market Street Akron, Ohio 44313-7188		
Attorney File : 6014-2		
CC:		

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Abstract

A

A plastic smart card, such as a card having a radio frequency identification (RFID) proximity function, including at least one electronic element embedded therein and a physical contact card function and the hot lamination process for the manufacture of this ~~micro-chip~~ ^{RFID function} smart card and other plastic cards including a micro-chip embedded therein. The process results in a card having a preferred overall thickness in the range of 0.028 inches to 0.032 inches with a surface suitable for receiving dye sublimation printing - the variation in card thickness across the surface should not exceed 0.0005 inches. A card manufactured in accordance with the present invention also complies with all industry standards and specifications. Also, the hot lamination process of the present invention results in an aesthetically pleasing card. The invention also relates to a plastic card formed in accordance with the hot lamination process of the present invention.

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**HOT LAMINATION PROCESS FOR THE MANUFACTURE
COMBINATION CONTACT/CONTACTLESS SMART CARD
AND PRODUCT RESULTING THEREFROM**

Field of the Invention

This application is a continuation-in-part of copending application 08/727,789 filed October 7, 1996.

The present invention relates generally to plastic cards and the manufacture thereof by a hot lamination process, and more particularly to smart cards and the manufacture of these such that they conform to industry size and performance standards and conventions and that have a superior outer surface as compared to known smart cards such that the card may receive dye sublimation printing or the like. Even more specifically, the preferred embodiments of the present invention relate to ^{dual function} "combi-chip" cards containing imbedded electronic elements as well as an exposed electronic contact surface.

Background of the Invention

As the use of plastic cards for credit cards, automated teller machine (ATM) cards, identification cards, and like continues to become more widespread, the problems associated with the use of such cards correspondingly increase. Credit card fraud and identification card fraud are becoming larger problems everyday, and this fraud has introduced uncertainties into our systems of commerce and our security systems. Using easily available technology, criminals are able to manufacture credit/debit cards, ATM cards, identification cards, and the like having another's account code, identification code, or other personal information embedded in the magnetic stripe thereof. Thus, for example, criminals may steal hundreds or thousands of legitimate credit card

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account numbers and manufacture many additional cards bearing the stolen information. These fraudulent cards are then usable by the criminals to purchase goods and to receive cash with the legitimate card holder and the card issuer left holding the bill.

Likewise, so called debit cards are becoming increasingly popular. These cards have stored thereon a certain amount of value for which the card owner has previously paid. For example, a subway rider may purchase a card good for *X* fares, with one fare being deducted from the card each time the owner rides the subway. Criminals have also been able to manipulate the data stored on these cards to defraud the merchants and others.

The ease in which criminals have been able to manufacture and or manipulate known cards results from the existence of the easily altered magnetic stripe storage medium used by known cards. These magnetic stripes are easily programmed and reprogrammed using commonly available technology. Thus, there has been found a need in the plastic card industry to provide a more secure plastic card that is very difficult or impossible to fraudulently manipulate.

The likely successor to magnetic stripe cards is known as a memory or smart card. A smart card can generally be described as a card having an integrated circuit with memory that is capable of making decisions. The category of smart cards can be further divided into subcategories based on the type of memory or type of communication with an associated card reader. Types of smart cards include contact cards (cards requiring physical touch between the terminal reader and the surface of the card) and contactless cards (cards which interact with the terminal reader using an electromagnetic coupling). Contactless cards may also be referred to as "proximity" cards. This technology may serve as a substitute for or be provided as an addition to the magnetic stripe on a card.

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A One specific type of smart card is a dual function contact/contactless microprocessor chip plastic card commonly referred to in the industry as a ~~COMBI CHIP~~ ^{dual function} card. This card utilizes a single microprocessor to control both physical contact and proximity features of the card.

While these smart cards have been found to have infinitely more capability than magnetic stripe cards as well as being more successful in preventing or limiting fraud, they are more difficult and expensive to manufacture relative to ordinary magnetic stripe cards. One of the biggest obstacles to the wide spread manufacture and use of smart cards has been the inability of card manufacturers to manufacture a smart card that meets all industry standards and specifications, such as those set by the International Standards Organization (ISO), that are sufficiently aesthetically pleasing (wherein the embedded electronics are hidden from view), and that have a sufficiently regular or flat surface such that one or both surfaces of the card may be printed on using the very popular and widespread dye sublimation technology.

Limitations to known plastic cards with embedded computer chips and electronics are that they a) are too thick to work in connection with existing card reading machinery (ATM machines, telephones, b) have a surface that is too irregular to properly and consistently receive dye sublimation printing, c) utilize manufacturing processes making the cards cost prohibitive. Moreover, prior attempts to manufacture a sufficiently thin plastic card including a computer chip embedded therein have resulted in a card with inferior aesthetic qualities such as the ability to see the embedded computer chip through the plastic.

Furthermore, due to the presence of both internal and surface electronics within the card, the manufacture of a ~~COMBI CHIP~~ ^{dual function} card presents its own unique set of obstacles and problems, different from the manufacture of cards with fully embedded electronics.

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Summary of the Invention

The present invention is therefore directed to a hot lamination method for the manufacture of a plastic card having at least one electronic element embedded therein as well as at least one electronic element with an exposed contact surface and to such plastic cards. The card has an overall thickness in the range of 0.028 inches to 0.032 inches and comprises a plastic core having at least one electronic element embedded therein with at least one of the upper and lower surfaces of the core comprising a coating printed or otherwise applied thereon. A portion of the card's outer surface exposes a contact surface electronic element operatively connected to the card's internal electronics. An overlamine film is preferably provided over the coated surface of the core and the resulting card has a variation in thickness across the surfaces thereof of no greater than approximately 0.0005 inches.

The hot lamination method of the present invention comprises the steps of providing upper (first) and lower (second) plastic core sheets, positioning at least one electronic element between the first and second core sheets to thus form a core, and placing the core in a laminator and closing the laminator with minimal or no laminator ram pressure applied to the core. A heat cycle is applied to the core sheets in the laminator to cause complete or partial flow of the plastic sheets. The laminator ram pressure is then increased in combination with the heat. A cooling cycle is then applied to the core in the laminator, preferably with an associated increase in ram pressure, and the core is removed from the laminator.

In the preferred embodiment, the laminated core next undergoes a controlled depth milling operation to expose one or more contact pads which comprise part of the internal, embedded electronic element.

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In alternative embodiments, one of the plastic sheets contained a pre-formed window which is positioned over the contact pads, prior to lamination. A spacer, integral to the corresponding platen or separate therefrom, is utilized to prevent or limit the flow of plastic into the window region so as not to coat the contact pads with plastic during the card manufacturing process.

At least one surface of the core is then printed on using a printing press or similar printing apparatus, a sheet of overlamine film is placed on at least one side of the core, and the core is once again placed in a laminator. A heat cycle is applied to the core with its overlamine film, and a cooling cycle is thereafter applied, resulting in a sheet of plastic card stock from which one or more cards may be cut.

Contact surface elements are installed into the window region of a plastic card and in operable contact with contact pads.

The invention is also directed to a card manufactured in accordance with the above process which results in a plastic card having a thickness in the range of approximately 0.028 inches to 0.032 inches with a surface smoothness of at least approximately 0.0005 inches as is required by International Standards Organization (ISO) and American National Standards Institute (ANSI) standards.

The present invention provides numerous advantages over known plastic cards and known plastic card manufacturing processes, and includes the formation of a plastic card with electronic elements such as a computer chip embedded therein with a pleasing aesthetic appearance, having a sufficiently smooth and regular surface such that the card may receive dye sublimation printing.

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and possessing sufficient durability and characteristics to comply with all industry specifications and standards.

Brief Description of The Drawings

Fig. 1 is a perspective view of a plastic card in accordance with the present invention;

Fig. 2 is a perspective view of the card shown in Fig. 1, illustrating the embedded and exposed electronics incorporated into the card;

^A
Fig. 2^a is a side plan-view of the card core illustrating various electronic elements that may be embedded in a card in accordance with the present invention;

^A
Fig. 3 is a cross sectional view of the card illustrated in Fig. 2, taken through section line 3a-3a.

^B
Fig. 3^a is a cross sectional view of the card illustrated in Fig. 2, taken through section line 3b-3b.

Fig. 4 is a perspective view of a plurality of electronic elements positioned on a sheet of plastic core stock and covered by a second sheet of plastic core stock.

Fig. 5 is a schematic cross sectional view illustrating a book comprising the core, containing electronics, as positioned in a laminator;

^A
Fig. 5^a is an enlarged cross-sectional view of the portion indicated in Fig. 5 for an alternative embodiment, utilizing a spacer, for producing a card according to the present invention;

Fig. 6 schematically illustrates the process of printing on the core;

Fig. 7 is a schematic cross sectional view illustrating the core with overlamine film, as placed in a laminator;

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Fig. 8 is an exploded view of a plastic card produced by the process of the present invention.

Detailed Description of the Invention

The present invention relates to a plastic card including at least one electronic element embedded therein. The present invention also relates to a hot lamination process for the manufacture of plastic cards, and more particularly to a hot lamination process for the manufacturer of plastic cards that include an electronic element, such as a computer chip or other electronic element embedded therein. The electronic element may perform a wide variety of functions and take a wide variety of forms. Such cards, without regard to the particular electronic element embedded therein, will hereinafter be referred to as smart cards. The present invention also relates to a card formed in accordance with the invention.

In its preferred embodiment and as illustrated in Figs. 1 and 2, the present invention relates to the manufacture of a ^{dual function} ~~combination~~ card, a particular type of smart card which utilizes a dual function contact/contactless microprocessor chip, as described previously herein. However, it will be appreciated by those skilled in the art, that the method of hot lamination described herein could easily be applied to other identity card or smart card applications.

Referring now to Figs. 1, 2, and 2A there can be seen a plastic card 10 manufactured in accordance with the present invention and including an electronic element, generally 20, embedded therein. Card 10 includes an upper surface 12 and a lower surface 14. Electronic element 20 may take a wide variety of forms (microprocessor chip, circuit board, transponder, etc.) and perform a wide variety of functions. As shown in Figs. 2, 2A, 3, and 3A, electronic

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element 20 may comprise a read/write micro-chip 22 including a wire antenna 24 connected thereto, any other suitable electronic element. These electronic elements 20, 22 and 24 and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements embedded therein such that the cards 10 are of a superior quality, meet all ISO and other industry specifications and standards, and are sufficiently smooth and otherwise is capable of receiving dye sublimation printing. Electronic elements such as these described are available from manufacturers such as Motorola and Philips Electronics.

Upper surface 12 contains a window or cavity 16 formed therein and intended to expose one or more contact pads 26 operatively connected to antenna 24. Upon formation of card 10 in accordance with the preferred embodiment, a microprocessor chip 22 is inserted into window 16 and in electrical connection with contact pads 26. This microprocessor chip may function as a "proximity" or radio frequency identification (RFID) card in conjunction with antenna 24 when electromagnetically used with a compatible terminal reader. Microprocessor chip 22 is also capable of function as a contact card, requiring physical contact between a compatible terminal reader and the surface of chip 22. It should be appreciated that the contact function of the card may be accomplished by any contact sensor whether integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of

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the microprocessor chip 22 surface as well as to the surface of plastic portion of card 10. It is to be appreciated that cards having a thickness greater than .032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in Fig. 4, one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20, including contact points 26, between first and second sheets of card stock 30, 32 to form a core 33. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32. When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32, electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator

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apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in Fig. 5, laminator 40 includes upper and lower platens 42,44 for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42,44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads of 60, 62 and the entire assembly forms a book ³⁷35 for being positioned in laminator 40 between platens 42, 44.

Once book ³⁷35 is positioned in laminator 40 as shown in Fig. 5, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book ³⁷35. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens 42,44 up to a range of 275°F to 400°F, and most preferably up to a range of 300°F to 370°F for a period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

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Once the heat cycle has been applied to book 35³⁷ as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 become encapsulated thereby, and so that sheets 30, 32 form a uniform core 33 with upper and lower surfaces 34,35. The ram pressure translates into an effective pressure on core 33 in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core 33, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates 50,52 provides surfaces 34,35 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10-15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core 33 surface, was applied for 10-15 minutes to form a uniform core 33, using sheets 30,32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

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Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 35³⁷ during which time the ram pressure of the laminator 40 is increased, preferably by approximately 10-40%

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and most preferably about 25% until the platens 42,44 have cooled so as to return the core material to a solid state. In the preferred method the platens 42, 44 are cooled to approximately 40°F to 65°F for approximately 10-15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in Fig.6, core 33 is coated on at least one of its upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in Fig. 6, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 can also serve to cosmetically hide the one or more electronic elements 20 that are embedded within core 33, and prevent these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to Fig.7, the final preferred, but optional processing of core 33, which now comprises a layer of ink 36 or the like on at least one surface 34,35 thereof, is schematically illustrated. An overlamine layer such as clear overlamine film 38 is positioned on at least one ink coated surface 34,35 of core 33, and preferably core 33 is positioned between two similar sheets of overlamine film 38,39 as shown. Overlamine film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is

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schematically illustrated in Fig. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlamine film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates ⁹¹90, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to Fig. 7.

When book 135 is positioned between upper and lower platens 42,44 of laminator 40 as shown in Fig. ⁷10, the laminator is closed and a heat cycle in the range of 175° F to 300° F, and most preferably in the range of 180°F to 275°F, is applied to book 135 for a period of 10 to 25 minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250-350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlamine layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40° F to 65° F and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlamine layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlamine layer 38 and should not cause softening or re-flow of plastic core 33. In lieu, of this preferred overlamination process, it is to be

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understood that colorfast inks may not require an overlamine layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34,35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlamine film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34,35 with a layer of ink 36 which is positioned between layers of overlamine film 38,39, all of which has been laminated together as described and as shown in Fig.8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12,14 at preferably both surfaces 12,14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy)

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or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26 and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in Fig. 5a, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon™. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that

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numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims.

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What is claimed is:

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1. A hot lamination process for the manufacture of a plastic card, said process comprising the steps of:
 - (a) providing first and second plastic core sheets;
 - (b) positioning at least one electronic element between said first and second plastic core sheets to form a layered core;
 - (c) positioning said core in a laminator apparatus, heating said core in said laminator, thereafter applying pressure to said core such that said at one electronic element is encapsulated in said core, and thereafter cooling said core in conjunction with laminator pressure being applied to said core, said core including an upper and lower surfaces;
 - (d) printing on at least one of said upper and lower surfaces of said core such that a layer of ink is applied to said at least one upper and lower surface of said core;
 - (e) cutting at least one card from said sheet of plastic card stock.
2. A hot lamination process as recited in claim 1 and having a further step, anywhere following step c), said step comprising: milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said electronic element.
3. A hot lamination process as recited in claim 1, wherein said step (c) of positioning said core in a laminator apparatus is carried out by positioning said core between first and second laminating plates, at least one of said first and second laminating plates having a matte finish to

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provide at least one of said upper and lower core surfaces with a correspondingly textured surface.

4. A hot lamination process as recited in claim 3, wherein at least one of said first and second laminating plates includes matte finish to provide both at least one outer surface of said core with a correspondingly textured surface.

5. A hot lamination process as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, wherein each of said sheets has a thickness in the range of 0.007 inches to 0.024 inches.

6. A hot lamination process as recited in claim 5, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inches.

7. A hot lamination process as recited in claim 1, wherein said step (c) is carried out by:

- (c1) constructing a first book including said core and at least first and second laminating plates respectively adjacent to said upper and lower surfaces of said core;
- (c2) positioning said book in said laminator apparatus;
- (c3) closing said laminator apparatus and heating said core for a first predetermined amount of time without applying essentially any laminator ram pressure to said core;

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(c4) increasing said laminator ram pressure following the passage of said first predetermined amount of time to apply pressure to said core in conjunction with said heating of said core; and,

(c5) cooling said core in said laminator in conjunction with laminator ram pressure being applied to said core.

8. A hot lamination process as recited in claim 7, wherein said step (c5) is carried out with a ram pressure that is greater than the ram pressure utilized in step (c4).

9. A hot lamination process as recited in claim 8, wherein the laminator pressure utilized in step (c5) ranges from about 10 to about 40% greater than the ram pressure utilized in step (c4).

10. A hot lamination process as recited in claim 7, wherein at least one of said first and second laminating plates is a matte finished laminating plate to provide at least one of said upper and lower surfaces of said core with a corresponding matte finish.

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A hot lamination process as recited in claim 1 having a further step following step (d), said step comprising: positioning said core in a laminator apparatus with a layer of overlamine film on at least one of said upper and lower surfaces of said core and laminating said layer of overlamine film to said core in said laminator to thereby form a sheet of plastic card stock.

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12. A hot lamination process as recited in claim 7, wherein said step (c3) is carried out by heating said core to a temperature in the range of 300°F to 370°F for at least 5 to 10 minutes.

13. A hot lamination process as recited in claim 12, wherein said step (c4) is carried out by increasing said laminator pressure to a pressure approximately in the range of 200 p.s.i. to 450 p.s.i. on said core for at least 10 minutes.

14. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a printing press.

15. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a coating techniques selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

16. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core between first and second sheets of overlamine film such that a layer of overlamine film is laminated to both said upper and lower surfaces of said core.

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1. A hot lamination process as recited in claim 1 comprising the further step of inserting an electronic contact element into said cavity.

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18. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board or wire antenna.

19. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

20. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core with said layer of overlamine film in said laminator apparatus between first and second laminating plates, wherein at least one of said first and second laminating plates includes a highly polished surface in contact with said layer of overlamine film.

21. A hot lamination process for the manufacture of a plastic card, said process comprising the steps of:

(a) providing first and second plastic core sheets, at least one core sheet having a cavity formed therein;

(b) positioning at least one electronic element having at least one electronic sub-component between said first and second plastic core sheets to form a layered core, said cavity positioned so as to expose said at least one contact pad therein;

(c) inserting a spacer into said cavity, said spacer substantially filling said cavity and covering said at least one electronic sub-component;

(d) positioning said core in a laminator apparatus, heating said core in said laminator, thereafter applying pressure to said core such that said at one electronic element is

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encapsulated in said core, and thereafter cooling said core in conjunction with laminator ram pressure being applied to said core, said core including an upper and lower surfaces;

- (e) printing on at least one of said upper and lower surfaces of said core such that a layer of ink is applied to said at least one upper and lower surface of said core;
- (f) removing said spacer from the cavity of said core;
- (g) cutting at least one card from said sheet of plastic card stock.

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22 A hot lamination process as recited in claim 21, wherein said electronic sub-component comprises one or more elements from the group consisting of a microprocessor chip, a contact pad, a transponder and a contact sensor.

23. A plastic card comprising:

- a plastic core including at least one electronic element embedded therein, said core having an upper surface and a lower surface;
- a coating on at least one of said upper and lower surfaces; and,
- a layer of overlamine film positioned on said at least one coated surface, wherein said card has an overall thickness in the range of approximately 0.028 inches to 0.032 inches with a variation in overall thickness across the upper and lower surfaces being no greater than approximately 0.0005 inches.

24. A plastic card as recited in claim 23, wherein said core is made from a plastic selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene.

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